Engineering Manual File Format Specification
Version: EM09 Revision 5

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1 Overview

The purpose of this document is to provide a detailed technical specification of the U.S. Army Corps of Engineers Engineering Manual (EM) survey file format. EM is an ASCII text-based file format, designed to be easy to create from survey data collector output, easy to read and understand, and easy to process with a computer program. The development of the EM file format was motivated by a desire to create a stand alone survey data file with internally self-documenting metadata. Surveyors can use this document as a guide for creating EM files. Likewise, software developers can use this document as a basis for developing systems to read, write, and otherwise process survey data.

The EM file format was originally documented in the 1994 version of Engineering Manual EM-1005 [1]. The format was subsequently adopted by the New Orleans District of the U.S. Army Corps of Engineers (CEMVN) and its surveying contractors as a standard delivery product. The specification was updated in 2006 to accommodate vertical datum and tidal epoch relationships and was published in the CEMVN Guide for Minimum Survey Standards for Performing Hydrographic, Topographic, and Geodetic Surveys [2]. Both specifications left several unresolved ambiguities in the file format. This document defines the organization of the EM file format and provide examples to help clarify it. For more details on the revision history refer to Section 15 of this document.

2 Organization

An EM file is divided into lines delimited by the newline character. Each line is limited to 80 characters in length. The character in the first column of a line determines how the line should be interpreted. There should be no blank lines in the file.

2.1 Comments

If the first column of a line is a semicolon (;), the line is treated as a comment. Comments are ignored by programs that read EM files. As such, comments are typically used to annotate different file sections or improve readability of the survey file. The first line in Listing 1 is an example of a comment.

Listing 1 EM header example.

```
;This is a comment
#H02 05/20/2003
#M01 SHOT POINTS
101,450601.99,3457829.99,10.99,GRN
```

2.2 Records

If the first column of a line contains a hash symbol (#), then the line is a record. Records define metadata information about the survey or attribution of survey features. The hash symbol is followed by a letter and two digits that determine the record type. Four special feature record codes (#X01, #P01, #A01, and #M01) are used to define survey features for cross-sections, profiles, areas, and miscellaneous shot points, respectively.

The text that follows the record declaration is the record's contents. For example, line 2 in Listing 1 contains an #H02 record, which represents a survey date. In this case, the date is May 20, 2003. Under no circumstances should a record include a placeholder for unknown information. For example, a survey should not include #V03 N/A to indicate the surveyor does not know the vertical datum of the benchmark that was used. In such cases, the record should be omitted entirely.

2.3 Survey Points

All lines not beginning with either a semicolon or a hash symbol are treated as survey points. Survey points represent individual locations, elevations, and classifications collected during the survey.

Survey points must be comma or space-delimited and must contain a point identifier followed by a northing, an easting, an elevation, and a feature code. An overview of the survey point structure is provided in Table 1. A survey point must be preceded by a line with a feature record declaration (#X01, #P01, #A01, or #M01) so that the survey point can be associated to a cross-section line, profile line, area, or miscellaneous shot point group. Line 4 in Listing 1 shows an example of a survey point with unique identifier 101, a northing of 450601.99 and an easting of 3457829.99. The elevation of this survey point is 10.99 and the feature code is GRN, indicating that the shot was taken on natural ground. A list of commonly-used feature codes is included in Section 14. The survey point is preceded by an #M01 record declaration on the third line, indicating that survey point 101 is logically associated with the SHOT POINTS feature.

Listing 2 EM record and survey point example.

```
;This is a comment
#H02 05/20/2003
#M01 SHOT POINTS
101,450601.99,3457829.99,10.99,GRN
;
#H02 05/21/2003
#M01 MORE SHOT POINTS
102,500960.30,3700343.72,-11.10,SND
103,500954.99,3700362.88,-13.30,SND
```

Metadata for survey points is specified by the last record of a given type that precedes the survey point. Listing 2 indicates that the survey point with identifier 101 was surveyed on 05/20/2003 and that the point is a miscellaneous shot point. On the other hand, survey points with identifiers 102 and 103 in Listing 2 were surveyed on 05/21/2003 and are part of the MORE SHOT POINTS feature, since a different #H02 and #M01 record declaration precedes them.

Sequence	Definition	Type	Comments
1	Coordinate Id	String	Each survey point in a survey file must have a unique coordinate id. An integer value is preferred for the coordinate id.
2	Northing	Real	The northing value must be based on the units defined in the survey's units record (#H06), coordinate system (#H07), horizontal datum (#H04), and horizontal epoch (#H16).
3	Easting	Real	The easting value must be based on the units defined in the survey's units record (#H06), coordinate system (#H07), horizontal datum (#H04), and horizontal epoch (#H16).
4	Elevation	Real	The elevation value must be based on the preceding vertical control declaration (#V01 or #T01), vertical datum (#V04), epoch (#V03) and the survey's units record (#H06).
5	Feature Code	String	Survey point classification. Preferably, this value should be one of the codes listed in Table 14 or in the survey's CODES.DAT file.

Table 1: Survey point structure. The Sequence column represents the order in which the value appears in the survey point.

3   Survey Job Records

Survey job records define general metadata applicable to the survey file or the entire survey job. These records are distinguished by an #H prefix and should be placed before any other records in the file. Some header codes such as date (#H02), field book (#H10), and page number (#H11) may repeat within a survey file and additional records of these types should be added to the survey file when the date, page number or field book changes. Table 2 lists valid survey job record codes.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#H00	Version	String	EM06,EM09		N	Y	Version of EM specification used to create the survey file. If this record is used, it must be the first line in the file that is not a comment.
#H01	Filename	String			N	N	Original name of submitted survey file.
#H02	Date	Date (MM/DD/YYYY)			Y	N	All records and survey point entries are interpreted as having been collected on the date of the last preceding #H02 record. Multiple dates must not be put in a single #H02 record.
#H03	Vertical Accuracy Classification	String	1-I, 1-II, 2-I, 2-II, 3, 4, +-accuracy		N	N	Vertical accuracy classification, as defined by the requester, based on USACE vertical accuracy standards documented in Engineering Manual EM1110-1-1004 [3]. Alternatively, an absolute accuracy can be specified with '+-' followed by a numeric value in units specified by the #H06 record.
#H04	Horizontal Datum	String	NAD83, NAD27		N	N	Horizontal datum of surveyed coordinates.
#H05	Job Number	String			N	N	Tracking number provided by USACE or requesting organization to uniquely identify a survey job.
#H06	Units of Measure	String	USFEET, METERS, IFEET, FT, SI, M		N	N	Units of measure used for horizontal and vertical components of survey coordinates. USFEET and FT represent U.S. Survey Feet. METERS, SI, and M represent meters. IFEET represents international feet. USFEET, METERS, and IFEET are the preferred values. Other values are retained for backward compatability.
#H07	Zone	String	1701, 1702, 1703, UTM15, UTM16*		N	N	State Plane or Universal Transverse Mercator (UTM) zone to which coordinates are referenced. UTM zones must be prefixed with the letters 'UTM'. (*Listed domain values are examples that are applicable in Louisiana. Domain values vary from state to state.)
#H08	Location	String			N	N	Textual description of the survey locations for the survey file. Location may be used to distinguish one survey file from another amongst files that are a part of the same job.
#H09	Survey Organization	String			N	N	Name of organization that conducted the survey.
#H10	Field Book	String			Y	Y	Reference name of survey field book. All records and survey point entries are interpreted as having been documented in the field book of the last preceding #H10 record.
#H11	Page Number	String			Y	Y	Page number of survey field book. All records and survey point entries are interpreted as having been recorded on the page number of the last preceding #H11 record.
#H12	Combined Scale Factor	Real			N	Y	Ratio of the grid to ground/geodetic distances over the entire survey area.
#H13	County/Parish Name	String			Y	Y	County or parish in which the survey was primarily conducted.
#H14	Quad Name	String			Y	Y	USGS 7.5 minute quad name in which survey was primarily conducted.
#H15	Contract Number	String			N	Y	USACE contract number establishing the authority to conduct the survey.
#H16	Horizontal Epoch	String	1986, HARN, NSRS2007, BASELINE, NA2011		N	Y	Horizontal epoch reference of the surveyed points. No #H16 record is required for NAD27 datum. If this record is not included, the 1986 epoch is assumed for NAD83 datum. BASELINE indicates that the horizontal control is tied to the baseline referenced in the #B00 record.
#H17	Horizontal Accuracy	String	1, 2-I, 2-II, 3-I, 3-II, 4, +-accuracy		N	Y	Horizontal accuracy classification based on USACE horizontal accuracy standards documented in Engineering Manual EM1110-1-1004 [3]. Alternatively, an absolute accuracy can be specified with '+-' followed by a numeric value in units specified by the #H06 record.
#H20 - #H29	Job Title	String			N	N	Survey Job Title. This title should be consistent among all survey files that comprise an individual survey job and may be provided by USACE or requesting organization.
#H30 - #H99	Comments	String			Y	Y	General comments about the survey job including horizontal and vertical accuracy, additional point of contact information, purpose of survey, and any difficulties that occurred during survey. If comments are longer than 80 characters, they may be continued on the following line, provided that the line is prepended with an #H30 - #H99 record code.

Table 2: Survey job record codes.

4 Vertical Control Records

All vertical control points (benchmarks), whether found or established, must be described by vertical control records in the survey file. Vertical control records provide information on the monumentation used to reference survey point locations and elevations. There are two types of vertical control records. Permanent benchmarks, prefixed with #V records (defined in Table 3), are control points that are included in the National Geodetic Survey (NGS) network and are distinguished by PID numbers. Temporary benchmarks, prefixed with #T records (defined in Table 4), are control points that are marked by a physical monument, but are not defined in the context of the national network as of the date of the survey.

The #V01 and #T01 records, which represent benchmark names, define new benchmark declarations. All other #V and #T records should appear in the survey file after a #V01 or #T01 record. These supplemental records define properties of the previously declared benchmark. The last vertical control declaration that appears before a survey feature represents the vertical control upon which the feature's coordinates and elevation are based. This information is useful for applying vertical datum and epoch adjustments. Once declared, a vertical control declaration can be re-used elsewhere in the survey file by re-declaring the previously used #V01 or #T01 record. In these cases, it is not necessary to add the additional #V or #T records unless they are different. An example is shown in Listing 3. The ALCO and A 375 benchmarks are declared first with their respective vertical datum, epoch, and other attributes. ALCO has a documented elevation of 6.1 feet, while A 375 has a documented elevation of 0.2 feet. The first survey feature references the A 375 benchmark since it was the last vertical control record listed before the survey feature. The second and third survey features are referenced to ALCO since ALCO is re-declared. In practice, all survey projects must document the project's primary control point and the additional point(s) used to validate its elevation. Therefore, each survey ought to contain a minimum of two vertical control records.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#V01	Name	String			Y	Y	Name of benchmark used in vertical control of the survey. This name should match the designation of a benchmark listed in the National Geodetic Survey (NGS) datasheets [4] unless explicitly directed by US-ACE or the requesting organization.
#V02	Published Elevation	Real		#V01	N	N	Published elevation of permanent benchmark as specified by NGS datasheet or similar authority, specified using the units defined in the #H06 record.
#V03	Epoch	String	1938, 1951, 1955, 1963, 1968, 1976, 1983, 1984, 1986, 1992, 1994, 2004.65, 2006.81, OPUS, GULFNET, OTHER	#V01	N	N	Name of time period associated with the datum. See the New Orleans District Engineering Survey Section FAQ[5] for more details.
#V04	Vertical Datum	String	NAVD88, NGVD29, MLG, MLLW, LMSL, LWRP, LWRP74, LWRP93	#V01	N	N	Vertical datum used for elevation reference.
#V05	Condition	String	GOOD, MONU-MENTED, POOR, MARK NOT FOUND, VERTICAL UPDATE	#V01	N	N	Condition in which benchmark was found during the survey.
#V06	Measured Elevation	Real		#V01	N	Y	Benchmark elevation measured during survey using the units defined in the #H06 record.
#V07	Horizontal Coordinates	Real (Y,X)		#V01	N	N	Northing and easting of benchmark location based on the units defined in the survey's units record (#H06), coordinate system (#H07), horizontal datum (#H04), and horizontal epoch (#H16). This value is represented by a comma-separated pair of real numbers corresponding to a northing and easting value. Northing value must always precede the easting value.
#V08	PID	String		#V01	N	Y	NGS benchmark identifier. This is only required if the benchmark has an NGS PID.
#V09	Vertical Adjustment	Real		#V01	N	Y	Vertical adjustments are used to translate surveys from one epoch to another or to correct surveys in which the measured benchmark elevation does not match the documented benchmark elevation. This adjustment is added to all subsequent survey point elevation values until the end of the file or until another #V09 record is specified.
#V10	Local Mean Sea Level Relationship	Real		#V01	N	Y	Established local mean sea level water surface elevation for the vicinity of the benchmark in units defined in the #H06 record minus the published elevation of the benchmark (#V02 record)[LMSL - #V02]. Local mean sea level elevation should be based on the National Tidal Epoch Period (#V12).
#V11	Mean Lower Low Water Relationship	Real		#V01	N	Y	Established mean lower low water surface elevation for the vicinity of the benchmark in units defined in the #H06 record minus the published elevation of the benchmark (#V02 record)[MLLW - #V02]. Mean lower low water elevation must be based on the National Tidal Epoch Period (#V12).
#V12	National Tidal Datum Epoch Period	See Description		#V01	N	Y	Starting and ending years of the period used to define sea level (#V10) and/or mean lower low water (#V11) for the area in the vicinity of the benchmark. The format of this value is a starting and ending year represented as integers separated by a dash (For example: 1983-2001).
#V20 - #V99	Description	String		#V01	Y	Y	Textual description of permanent benchmark. If benchmark description is longer than 80 characters, the description may be continued on the following line, provided that line is prepended with a #V20-#V99 record code.

Table 3: Permanent benchmark record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

Listing 3 Multiple vertical control example. Survey feature 1 references the A 375 benchmark, while features 2 and 3 reference the ALCO benchmark.

```
; Vertical Control Information
#V01 ALCO
#V02 6.1
#V03 2004.65
#V04 NAVD88
#V05 GOOD
#V06 6.14
#V07 557299.69,3667048.45
#V08 BJ1342
;
; Vertical Control Information
#V01 A 375
#V02 0.2
#V03 2004.65
#V04 NAVD88
#V05 GOOD
#V06 0.2
#V07 575567.53,3720265.83
#V08 BH1811
;
; Survey Feature 1 : References A 375 benchmark
;
#X01 3087987.07  603432.45 3088120.65  603414.41 12100.00 121+00
13205,603421.06,3088071.14,16.05,TBK
13213,603423.05,3088056.70,3.72,THG
13223,603426.21,3088036.43,16.22,TBK
;
; Re-declaration of ALCO benchmark
;
#V01 ALCO
;
; Survey Feature 2: References ALCO Benchmark
;
#X01 3087993.16  603453.37 3088122.69  603436.39 12200.00 122+00
13174,603443.28,3088073.66,16.38,TBK
13181,603446.09,3088059.18,4.09,THG
13188,603446.69,3088045.62,16.02,SLP
;
; Survey Feature 3: Still References ALCO Benchmark
;
#X01 3087922.16  603481.37 3088745.69  603455.39 12300.00 123+00
13194,603451.95,3088003.68,16.77,NG
13195,603452.85,3087996.99,16.90,NG
```

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#T01	Name	String			Y	Y	Name of temporary benchmark as designated by US-ACE or other requesting agency.
#T02	Published Elevation	Real		#T01	N	Y	Published elevation of temporary benchmark as provided by USACE or other requesting agency.
#T05	Condition	String	GOOD, MONU-MENTED, POOR, MARK NOT FOUND	#T01	N	N	Condition in which benchmark was found during the survey.
#T06	Measured Elevation	Real		#T01	N	N	Benchmark elevation measured during survey using the units defined in the #H06 record.
#T07	Horizontal Coordinates	Real (Y,X)		#T01	N	N	Northing and easting of benchmark location based on the units defined in the survey's units record (#H06), coordinate system (#H07), horizontal datum (#H04), and horizontal epoch (#H16). This value is represented by a comma-separated pair of real numbers corresponding to a northing and easting value. Northing value must always precede the easting value.
#T10 - #T99	Description	String		#T01	Y	Y	Textual description of temporary benchmark. If benchmark description is longer than 80 characters, the description may be continued on the following line, provided that line is prepended with a #T10-#T99 record code.

Table 4: Temporary benchmark record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

5 Gage Records

Gage records must be included in hydrographic surveys whenever a gage is read over the course of a survey. Sounding elevations are calculated from a depth reading and gage reading of the water surface elevation. As the water surface elevation may be influenced by tides, it is also important to capture the date and time of the water surface elevation. A gage is declared with a gage name (#G02) record. The first use of the game name record can be preceded by a gage identifier record (#G01) if the gage is provided by USACE, NOAA, or another authoritative agency. The last vertical control record (#T01 or #V01) listed before the initial declaration of a gage is assumed to be the basis of the gage's calibration. Once a gage is declared, its readings can be recorded as water surface elevation (#G03) and time (#G04) records. Table 5 lists valid gage record codes. Hydrographic survey features are referenced to the last gage name (#G02), water surface elevation (#G03), and time (#G04) that precede the survey feature. In Listing 4, gage G-1 is read once at 7:00 and used to reference the first cross-section. The same gage is read again at 13:00 and used to reference the second cross-section. Refer to the Engineer Manual for Hydrographic Surveying [6] for guidance on gage usage.

Listing 4 Gage example. Survey feature 1 references gage G-1 at 7:00 AM. Survey feature 2 references gage G-1 at 1:00 PM. Reuse of G-1 requires only the #G02, #G03, and #G04 records.

```
; Survey Date
#H02 10/10/2002
; Vertical Control Information
#V01 ALCO
#V02 6.1
#V03 2004.64
#V04 NAVD88
#V07 557299.69,3667048.45
;
; Gage information
;
; First gage, G-1, referenced to ALCO
;
#G02 G-1
#G03 0.32
#G04 0700
#G05 0.2
#G07 557279.69,3667058.45
#G10 TEMPORARY STAKE GAGE SET AT END OF CANAL
;
; Survey Feature 1 : Sounding elevations (SND)
; are calculated relative to water surface elevation
; of gage G-1 at 0700 hours (7:00 AM).
;
#X01 3087987.07  603432.45 3088120.65  603414.41 12100.00 121+00
13205,603421.06,3088071.14,16.05,TBK
13213,603423.05,3088056.70,-3.72,BOT
13223,603426.21,3088036.43,16.22,TBK
;
; Gage G-1 reading at 13:00
;
#G02 G-1
#G03 0.1
#G04 1300

;
; Survey Feature 2 : Sounding elevations (SND)
; are calculated relative to water surface elevation
; of gage G-1 at 1300 hours (1:00 PM).
;
#X01 3087993.16  603453.37 3088122.69  603436.39 12200.00 122+00
13174,603443.28,3088073.66,-16.38,SND
13181,603446.09,3088059.18,-20.09,SND
13188,603446.69,3088045.62,-16.02,SND
```

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#G01	Gage Id	String			Y	Y	USACE, USGS, or NOAA gage id.
#G02	Name	String			Y	Y	Gage Name.
#G03	Water Surface Elevation	Real		#G02	N	N	Water surface elevation read at the gage, based on units in the survey's #H06 record.
#G04	Gage Reading Time	Time (HHMM)		#G02	N	N	Time of gage reading in military units (0000 - 2359).
#G05	Local Mean Sea Level Reference	Real		#G02	N	Y	The elevation of the Local Mean Sea Level at the gage site relative to the vertical datum and epoch specified on the previous #V04 and epoch #V03 records respectively in the units specified by the #H06 record. If the gage zero is set to local mean sea level, then this value can be subtracted from gage readings to calculate the water surface elevation relative to the survey's vertical datum and epoch: $Z_{\#G03} - Z_{\#G05} = Z_{\#V03,\#V04}$
#G06	Mean Lower Low Water Reference	Real		#G02	N	Y	The elevation of the Local Mean Lower Low Water at the gage site relative to the vertical datum and epoch specified on the previous #V04 and #V03 records respectively in the units specified by the #H06 record. If the gage zero is set to mean lower low water, then this value can be subtracted from gage readings to calculate the water surface elevation relative to the survey's vertical datum and epoch: $Z_{\#G03} - Z_{\#G06} = Z_{\#V03,\#V04}$
#G07	Horizontal Coordinates	Real (Y,X)		#G02	N	Y	Northing and easting of gage location measured based on the units defined in the survey's units record (#H06), coordinate system (#H07), horizontal datum (#H04), and horizontal epoch (#H16). This value is represented by a comma-separated pair of real numbers corresponding to a northing and easting value. Northing value must always precede the easting value.
#G10 -#G99	Description	String		#G02	Y	Y	Gage Description. If gage description is longer than 80 characters, the description may be continued on the following line, provided that line is prepended with a #G10-#G99 record code.

Table 5: Gage record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

6 Equipment Records

Equipment records describe the equipment used to collect survey points. A piece of equipment is declared with an #E01 record. Once the equipment record is declared, additional information such as serial number (#E02) and instrument type (#E03) can be added. Table 6 describes the equipment record codes.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#E01	Instrument	String			Y	Y	Name of an instrument used during the survey.
#E02	Serial Number	String		#E01	N	Y	Instrument serial number.
#E03	Instrument Type	String	LEVEL, TOTAL STATION, GPS, RTK, VRS, SONAR, OTHER	#E01	N	Y	Type of survey equipment.
#E10-#E99	Description	String		#E01	Y	Y	Textual description of equipment or survey notes concerning the equipment.

Table 6: Equipment record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

7   Crew Records

Crew records are used to identify the individuals who participated in a survey and their team roles. Table 7 describes the crew record codes. An example is shown in Listing 5.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#C01	Party Chief	String			Y	Y	Name of party chief.
#C02	Instrument Man	String			Y	Y	Name of instrument person.
#C03	Rodman	String			Y	Y	Name of rodman.
#C04-#C99	Miscellaneous Crew Member	String			Y	Y	Name of an individual who participated in the survey, but was not the party chief, rodman, or instrument man.

Table 7: Crew record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

Listing 5 Crew example. First initials and last names are used for these crew record entries.

```
; Party Chief
;
#C01 S. GUERRA
;
; Instrument Personnel
;
#C02 W. CASHEN
#C02 S. FALCHOOK
;
; Rod Personnel
;
#C03 C. HUNTER
;
; Truck Driver
;
#C04 M. AURAND
```

---

8 Weather Records

Weather records are used to record weather conditions at the time of the survey. A weather observation must include a temperature record code (#W01) as a minimum and must be preceded by a date record (#H02) on which the weather was observed. Table 8 lists the valid weather record codes that can be used to describe the weather during the time of the survey. All weather record data should include the measurement followed by units or a percentage sign (%) where applicable as demonstrated in Listing 6. In this example, two weather observations were made on the same day.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#W01	Temperature	String		#H02	N	N	Observed temperature.
#W02	Air Pressure	String		#H02	N	Y	Observed air pressure.
#W03	Humidity	String		#H02	N	Y	Observed relative humidity measured as a percentage.
#W04	Cloud Conditions	String		#H02	N	Y	Cloud coverage measured as a percentage. A value of 0% represents clear conditions and 100% represents overcast conditions.
#W05	Wind Speed	String		#H02	N	Y	Observed wind speed.
#W06	Wind Direction	String	N, S, E, W, NE , SE, SW, NW	#H02	N	Y	Observed wind direction.

Table 8: Weather record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

Listing 6 Weather example. The second observation shows the change in temperature from 85 degrees to 95 degrees.

```
;
; First weather observation
;
#H02 10/10/2002
;
#W01 85 DEGREES
#W02 30.02 INCHES
#W03 68%
#W04 10%
#W05 5 MPH
#W06 SE
;
; Second weather observation
;
#H02 10/10/2002
;
#W01 95 DEGREES
;
```

---

9 Baseline Records

Baseline records are used to define points of inflection along the baseline of a survey. Baseline points include the easting, northing, and numerical station value of the baseline point. Cross-sections and profiles are typically referenced to positions along a baseline identified by a station value. Typically, multiple survey files in the same job will reference the same baseline. In these cases, the #B00 record can be used to specify a separate baseline file. If a survey references more than one baseline, the survey must be divided into separate EM files, each referencing its own baseline.

The syntax of a baseline file is the same as the syntax of a regular EM file. However, a baseline file may not include any cross-section (#X01), profile (#P01), area (#A01), or miscellaneous shot point (#M01) records. A baseline file name must have a .bl (or .BL) extension and should include a series of station coordinate records that include the easting, northing, station, and, optionally, name of points along the baseline. Baseline points must be listed in sequential order. The baseline record codes are listed in Table 9. An example is shown in Listing 7 (the EM file with #B00 record) and Listing 8 (the baseline associated to the EM file).

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#B00	Baseline File Reference	String			N	Y	Relative path and filename of baseline, if a separate file is used. Unix or DOS path separators may be used, if necessary.
#B01 - #B999	Station Coordinate	See Description			Y	N	Baseline coordinate represented as an easting and northing coordinate followed by a station and an optional name value. Values should be space delimited (X Y STAT NAME). X, Y, and STAT are real values. The X value always precedes the Y value for baseline points. If NAME is included, it may contain spaces. If more than 100 baseline points are required, #B100-#B999 can be used.

Table 9: Baseline record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

Listing 7 Baseline example. The EM survey file, 061005.EM includes a reference to the baseline file, 061005.BL on the sixth line using a #B00 record.

```
; Contents of 061005.EM
; Header information
#H01 061005.EM
#H02 10/10/2002
;
#B00 061005.BL
;
#X01 3087987.07  603432.45 3088120.65  603414.41 1.00 UPSTREAM
13205,603421.06,3088071.14,16.05,TBK
13213,603423.05,3088056.70,3.72,SND
13223,603426.21,3088036.43,16.22,TBK
```

Listing 8 Baseline example. The Baseline file, 061005.BL includes station coordinate record codes (#B01-#B999), followed by easting, northing, station, and names.

```
; Contents of 061005.BL showing different possible
; names
#B01 308109.34 603499.28 0.0 Sta. EH-01
#B02 308122.55 603515.44 385.10 3+85.10
#B03 308137.92 603527.81 415.22 4+15.22B/L=999.20LMS
;
```

---

10 Cross-Section Data Records

Cross-section records precede a collection of survey points that comprise a cross-section, a survey feature that is taken across a waterway, levee, or other physical feature that is linear in nature. The #X01 record, which declares a cross-section feature, defines the starting and ending point coordinates of the cross-section range line, its range line station number, and, optionally, its cross-section name. The range line defines the name of a location that is surveyed repeatedly to compare the feature's topography with itself over time. The cross-section station numerically defines the position of the cross-section along the path of the physical feature being surveyed. All survey points that appear between the #X01 record and the next #X01, #M01, #A01, or #P01 record are associated exclusively to that cross-section. The survey points for a cross-section are not required to be in a specific order. Software programs that implement the EM format should sort the cross-section points in ascending order based on the projected distance of the cross-section points from the range line start point to the range line end point.

Additional information can be added to a cross-section definition, including range name (#X02), cross-section time (#X03), and assumed water surface elevation (#X04). The range name is only needed if the range name is different from the cross-section name. The cross-section time record is used to record the surveying start time of a hydrographic cross-section. The assumed water surface elevation is reported when the water surface elevation used to calculate cross-section elevations has been interpolated from multiple gages. Otherwise, the gage record water surface elevation (#G04) is sufficient. Descriptions of the cross-section record codes are provided in Table 10.

Cross-section elevations are referenced to the preceding benchmark reference (#V01 or #T01) and gage reference (#G02, #G03, and #G04) records, if applicable. The date on which the cross-section was surveyed is reflected by the preceding date record (#H02). If field book information is listed, then the book name and page numbers are reflected by the preceding field book (#H10) and page number (#H11) records. Listing 9 shows a single cross-section named XSEC1 that has starting range line coordinate (3664412.798, 554165.117), ending range line coordinate (3664639.354, 554144.167), and station 153.57. The survey points that follow are associated to the cross-section, XSEC1.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#X01	Start of a Cross-Section Feature	See Description			Y	Y	Cross-section initializer. Starting and ending easting and northing value pairs corresponding to the starting and ending coordinates of the cross-section range line, followed by the station and the cross-section identifier (X1 Y1 X2 Y2 STAT [NAME]). Values are separated by a single space and eastings precede northing values. X1, Y1, X2, Y2, and STAT are Real values. NAME is an optional text value that may contain spaces. All survey points that follow up to the next #A01, #X01, #P01, or #M01 record are associated with the same cross-section.
#X02	Range Name	String		#X01	N	Y	Name of the associated cross-section range line, if this exists and differs from the cross-section identifier (NAME) in #X01.
#X03	Cross-Section Start Time	Time (HHMM)		#X01	N	Y	Start time of cross-section data sampling.
#X04	Water Surface Elevation	Real		#X01	N	Y	Cross-section water surface elevation calculated for the start of cross-section sampling.
#X10-#X99	Description	String		#X01	Y	Y	Textual description of cross-section or survey notes concerning the cross-section.

Table 10: Cross-section record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

Listing 9 Cross-section example. In the #X01 record, coordinates (3664412.798, 554165.117) and (3664639.354, 554144.167) represent the range line end points. 153.57 is the station number of the cross-section relative to its baseline. XSEC1 is the name of the cross-section.

```
#X01 3664412.798 554165.117 3664639.354 554144.167 153.57 XSEC1
4,554165.117,3664412.798,12.189,TCW
6,554163.858,3664422.424,4.071,CRN
7,554162.375,3664434.061,0.842,SLP
8,554160.171,3664446.333,-1.525,TOE
10,554157.192,3664478.962,-3.013,NG
19,554144.167,3664639.354,-5.774,FL
```

11 Profile Data Records

Profile records precede a collection of survey points that comprise a profile, a survey feature that is taken along the path of a waterway, levee, or other physical feature that is linear in nature. A profile is declared by a #P01 record, which includes the starting point coordinate, starting station, and, optionally, the name of the profile. Profile points must be recorded in order and a profile line must not intersect itself. All survey points that appear between the #P01 record and the next #X01, #M01, #A01, or #P01 record are associated exclusively to that profile.

Additional information can be added to a profile definition, including profile time (#P03) and assumed water surface elevation (#P04). The profile time record is used to record the surveying start time of a hydrographic profile. The assumed water surface elevation is reported when the water surface elevation used to calculate profile elevations has been interpolated from multiple gages. Otherwise, the gage record water surface elevation (#G04) is sufficient. Description of the profile record codes is provided in Table 11.

Profile elevations are referenced to the preceding benchmark reference (#V01 or #T01) and gage reference (#G02, #G03, and #G04) records, if applicable. The date on which the profile was surveyed is reflected by the preceding date record (#H02). If field book information is recorded, then the book name and page numbers are reflected by the preceding field book (#H10) and page number (#H11) records. If the reference benchmark, gage, or date changes in the middle of a profile, then a new profile should be defined that continues from the previous profile (including the last point from the previous profile). Listing 10 shows a single profile named MUGL that has starting coordinate (3698572.642, 530389.323) and station 10.0. The survey points that follow are associated to the MUGL profile.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#P01	Start of Profile Feature	See Description			Y	Y	Profile initializer. Starting easting and northing of the profile, followed by the profile's starting station and name (X Y STAT [NAME]). Values are separated by a single space. X, Y and STAT are real numbers. NAME is an optional text value that may contain spaces. All survey points that follow up to the next #A01, #X01, #P01, or #M01 record are associated with the same profile.
#P03	Profile Start Time	Time (HHMM)		#P01	N	Y	Start time of profile data sampling.
#P04	Water Surface Elevation	Real		#P01	N	Y	Profile water surface elevation calculated for the start of profile sampling.
#P10-#P99	Description	String		#P01	Y	Y	Textual description of profile or survey notes concerning the profile.

Table 11: Profile record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

Listing 10 Profile example. In the #P01 record, the coordinate (3698572.642, 530389.323) is used as the starting point, 10.0 is the starting station, and MUGL is the name of the profile.

```
#P01 3698572.642 530389.323 10.0 MUGL
190,530119.038,3698954.414,20.468,CLL
191,530091.177,3699005.658,20.553,CLL
192,530057.379,3699067.854,20.363,CLL
```

12   Area Data Records

Area records describe polygonal surveyed features such as property boundaries or borrow pits. An area feature is declared with an #A01 record. All survey points that appear after the #A01 record are included in the exterior boundary of the polygon. Any number of holes may be added to the polygon feature by adding hole records (#A02) after the #A01 record declaration and its exterior boundary survey points. Holes must be completely contained within the exterior boundary. Any number of islands may be added to holes within the polygon feature by adding interior boundary records (#A03) after the #A02 record declaration and its boundary points. Interior boundaries (#A03) should be completely contained within the previously declared hole record (#A02). Descriptions of these record codes are shown in Table 12. The order of points defines the path of segments within the polygon. An example is shown in Listing 11.

In some area surveys, the first point will be surveyed again after all the other points are surveyed to check accuracy. In such cases software interpreting EM files should exclude the last survey point from rendering polygons if the last point of a ring falls within a planar tolereance distance of first point of the same ring. This tolerance distance is specified by the Horizontal Accuracy (#H17) record.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#A01	Exterior Boundary	String			Y	Y	Area feature initializer. Optional description of the area boundary being surveyed. All survey points that follow up to the next #A01, #A02, #A03, #X01, #P01, or #M01 record are associated to the exterior boundary of the area.
#A02	Hole	String		#A01	N	Y	Area feature modifier. Description of the hole within the area being surveyed. All survey points that follow up to the next #A01, #A02, #A03, #X01, #P01, or #M01 record are associated to this hole.
#A03	Interior Boundary	String		#A02	N	Y	Area feature modifier. Description of the island surveyed. All survey points that follow up to the next #A01, #A02, #A03, #X01, #P01, or #M01 record are associated to the interior boundary.
#A10-#A99	Description	String		#A01	Y	Y	Textual description of the area or survey notes concerning the area.

Table 12: Area record codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

Listing 11 Area example. In the #A01 record (named PROPERTY BOUNDARY), the coordinate (309213.27,3873567.51) is used as the starting point. Two holes and an island are included.

```
#A01 PROPERTY BOUNDARY
300,309213.27,3873567.51,0.00,COR
301,308761.10,3873725.18,0.00,COR
302,308731.83,3872661.42,0.00,COR
303,307959.25,3872837.80,0.00,COR
304,306801.11,3873101.86,0.00,COR
305,307687.45,3874132.54,0.00,COR
306,308680.72,3873744.26,0.00,COR
;
#A02 HOLE
308,307564.67,3872127.93,0,BLD
309,307681.51,3873652.17,0,BLD
310,307193.51,3873246.65,0,BLD
311,307564.21,3872127.90,0,BLD
;
#A02 HOLE
312,308630.03,3873882.36,0,BLD
313,308719.38,3873480.34,0,BLD
314,308155.77,3873281.01,0,BLD
315,308630.19,3873882.33,0,BLD
;
#A03 ISLAND
316,308561.30,3873163.17,0,NG
317,308664.40,3873315.38,0,NG
318,308568.18,3873246.65,0,NG
319,308561.31,3873163.16,0,NG
```

13   Miscellaneous Data Records

Miscellaneous shot point records precede a collection of survey points that are not part of a profile, cross-section, or area feature. A miscellaneous shot point group is declared by an #M01 record. The #M01 record includes a textual description of the common properties of the subsequent survey points. If the textual description exceeds 80 characters, it may be continued on the next line by additional #M records that precede the survey points. All survey points that appear between the #M01 record and the subsequent #A01, #X01, #M01, or #P01 record are associated exclusively to that miscellaneous shot point group. Descriptions of miscellanous shot point record codes are provided in Table 13.

Miscellaneous shot point elevations are referenced to the preceding benchmark reference (#V01 or #T01). The date on which the shot points were surveyed is reflected by the preceding date record (#H02). If field book information is recorded, then the book name and page numbers are reflected by the preceding field book (#H10) and page number (#H11) records. Survey points that have different benchmark references or survey dates should not be included in the same miscellaneous shot point group.

Record	Description	Type	Domain	Prerequisite	Repeatable?	Optional?	Comments
#M01 - #M99	Miscellaneous shot points	String			Y	N	Miscellaneous shot points initializer. Optional description of the area boundary being surveyed. All survey points that follow up to the next #X01, #P01, #A01, or #M01 record are associated with the same miscellaneous shot point group.

Table 13: Miscellaneous Shot Point Record Codes. If a prerequisite is defined for a given record code, then the repeatable and optional parameters apply to instances of the given record code that occur between instances of the prerequisite code.

14   Feature Codes

Feature codes appear at the end of each survey point and typically contain two or three consecutive upper-case characters that store an abbreviated code for the type of survey point. Standard feature codes are shown in Table 14. If a feature code is not listed in Table 14, an additional text file named CODES.DAT may be submitted with the survey. This file should reside in the same directory as the survey file and should include a semi-colon delimited list of feature codes and their definitions. Each line in the CODES.DAT file must contain only one code/definition pair and the file should not contain any blank lines or codes that are already defined in Table 14. Codes defined in the CODES.DAT file should be upper-case. Software that reads EM files should match codes from surveys to standard code definitions and CODES.DAT definitions without regard as to whether the characters in the code are upper or lower case.

Code	Definition	Code	Definition
AC	TOP OF ARTICULATED CONCRETE PAD	CRA	CENTERLINE OF RAIL
AP	ABANDONED PIPE	CRB	CURB
APR	APRON	CR	CROWN OF LEVEE
ASP	ASPHALT	CRN	CROWN
ATO	ABUTMENT TOE	CRT	CROSSTIE
ATP	ABUTMENT TOP	CRW	CONCRETE RETAINING WALL
BAL	BALLAST	CSP	CONCRETE AT SWIMMING POOL
BBP	BOTTOM OF BORROW PIT	CTD	CENTER OF DRAIN
BBT	BOTTOM OF BENT	CTH	CATCH BASIN
BCR	BRIDGE CORNER	CTN	COTTONWOOD TREE
BEG	BEGIN CROSS SECTION/PROFILE	CUB	BOTTOM OF CULVERT
BFB	BRICK FLOWER BED	CUL	CULVERT
BF	BRIDGE FENDER	CYP	CYPRESS TREE
BL	BASELINE	CYS	CYPRESS TREES
BM	BENCHMARK	DGS	DOGWOOD TREES
BLD	BUILDING	DKE	DIKE
BLK	BULKHEAD	DRI	DROP INLET
BNT	BENT OF BRIDGE	DRN	DRAIN
BOD	BOTTOM OF DITCH	DDR	DEAD DOG ON ROAD
BOS	BOTTOM OF STREAM	DRV	DRIVE
BOT	BOTTOM	EAR	EDGE OF AGGREGATE ROAD
BRC	BRIDGE CONCRETE	ECB	EDGE CONCRETE BRIDGE
BRF	BRIDGE FENDER	EC	EDGE CONCRETE
BRK	BREAKLINE	ECC	EDGE CONCRETE CURB
BRW	BREAK WALL	ECR	EDGE CONCRETE ROAD
BS	BUSH	ECW	EDGE OF WALL
BW	BRICK WALL	EDR	EDGE OF DIRT ROAD
CAL	CALIBRATION POINT	EFB	EDGE OF FLOWER BED
CAR	CENTERLINE OF AGGREGATE ROAD	EGL	EDGE OF GRASS LINE
CAP	CONCRETE APRON	ELI	EDGE OF LIMESTONE
CA	CONCRETE ASPHALT	ELM	ELM TREE
CB	CATCH BASIN	ELS	ELM TREES
CBC	CABLE LINE	EMG	EDGE OF METAL GRATING
CBK	CONCRETE BULKHEAD	END	END CROSS SECTION/PROFILE
CBL	CABLE	EOA	EDGE OF ASPHALT
CBT	CONCRETE BLUT TOE	EOB	EDGE OF BRIDGE
CCL	CENTERLINE OF CONCRETE CULVERT	EOC	EDGE OF CULVERT
CCP	CENTERLINE OF CONCRETE PAD	EOR	EDGE OF RIPRAP
CCR	CENTERLINE OF CONCRETE CURB	EOM	EDGE OF MEDIAN
CDR	CONCRETE DRIVE	EP	EDGE OF PLATFORM
CFP	CORNER FLAGPOLE BASE	EPL	EDGE OF PARKING LOT
CG	CATTLE GUARD	ER	EDGE OF ROAD
CH	CORNER HOUSE	ERF	EDGE OF ROAD FLOOD SIDE
CK	CHECK SHOT	ERP	EDGE OF ROAD PROTECTED SIDE
CHW	CENTERLINE OF HEAD WALL	ESH	EDGE SHELL ROAD
CLG	CENTERLINE GABION	ESL	EDGE OF SLAG ROAD
CL	CENTERLINE	ESP	EDGE SHEET PILE
CLB	CENTERLINE OF BRIDGE	ESR	EDGE SHELL ROAD
CLC	CENTER OF CONCRETE	EW	EDGE WOODS
CLD	CENTER OF DITCH	FEP	FENCE POST
CLI	CENTERLINE	FC	FENCE CORNER
CLL	CENTERLINE LEVEE	FIP	4 INCH POST
CLR	CENTERLINE OF ROAD	FL	FENCE LINE
CLW	CENTERLINE OF WALKWAY	FLB	FENCE LINE BRICK
CND	CONDUIT	FLC	FENCE LINE CHAIN LINK FENCE
CNL	CANAL	FLD	FLOOD WALL
COH	CONCRETE HEAD WALL	FLW	FENCE LINE WOODEN
CON	CONCRETE	FP	FLY POINT
COR	CORNER	FS	FLOOD SIDE LEVEE
CP	CRAPE MYRTLE TREE	FSC	FLOOD SIDE CROWN
CPG	CONCRETE PILING	FST	FLOOD SIDE TOE
CPT	CYPRESS TREE	FTG	FOOTING
CRD	CROWN OF DIKE	GAC	GROUND AT CULVERT
CRK	CENTERLINE ROCK	GAG	GROUND AT GATE

Code	Definition
GAP	GROUND AT PIER
GAT	GATE
GGE	GAGE
GL	GAS LINE
GM	GAS METER
GRN	GROUND
GR	GUARD RAIL
GRV	GRAVEL
GTB	GAS TEST BOX
GUY	GUY WIRE
GVL	GAS VALVE
HBK	HIGH BANK
HBS	HACKBERRY TREES
HED	HEDGES
HL	HEDGE LINE
HSE	HOUSE
HT	10 INCH HACKBERRY TREE
HUB	HUB
HWL	HEAD WALL
HYD	FIRE HYDRANT
INV	PIPE INVERT
IP	IRON PIPE
IRL	IRON RAIL
IR	IRON ROD
LC	LOW CORD
LDR	LIDAR
LPL	LIGHT POLE
LW	LOW WIRE
MB	MULBERRY TREE
MBX	MAIL BOX
MET	METAL - TOP OF GATES
MF	MUD FLAT
MGT	MAGNOLIA TREE
MH	MANHOLE COVER
MON	MONUMENT
MSH	MARSH
MTR	METER
MTX	METER BOX
NG	NATURAL GROUND
NGP	NATURAL GROUND AT PILING
NS	NORTH SIDE
OCV	OVERHEAD CONVEYOR
OH	OVERHEAD POWER LINES
OT	OAK TREE
OTS	OAK TREES
PC	PECAN TREE
PCS	PECAN TREES
PIC	PIPE INVERT - CONCRETE
PIM	PIPE INVERT - CORRUGATED METAL
PIN	PIPE INVERT
PIP	PIPE INVERT - PLASTIC
PIR	PIER
PIS	PIPE INVERT - STEEL
PIZ	PIEZOMETER
PL	PIPELINE CROSSING
PLC	POWER LINE CROSSING
PLG	PILING
PLT	PLATFORM
POR	PORCH
PPE	PIPE
PPL	POWER POLE
PP	PICTURE POINT
PRK	PIPE RACK
PSC	PROTECTED SIDE CROWN

Code	Definition
PST	PROTECTED SIDE TOE
PS	PROTECTED SIDE LEVEE
PT	10 INCH PINE TREE
PTS	PINE TREES
PVC	PVC PIPE
PWC	4 INCH POST WITH CABLE
PWL	POWERLINE
RAL	GUARD RAIL
RCK	ROCK
RCP	PIPE INVERT - REINFORCED CONCRETE
RD	ROAD
RMP	RAMP
RDM	RED DAY MARKER
ROW	RIGHT OF WAY
RP	RIPRAP
RR	RAILROAD
RRP	RAILROAD POST
SCO	SEWER CLEAR OUT
SG	SECTOR GATE
SGN	SIGN
SGP	SIGN POST
SS	SOUTH SIDE
SHD	SHOULDER
SP	SHEET PILING
SHL	SHELL
SLP	SLOPE SHOT
SND	SOUNDINGS
SNG	SOUNDINGS
SOC	SLOPE ON CONCRETE
SRR	SLOPE ON RIP RAP
SPT	TOE OF SHEET PILING
SPV	SLOPE PAVING
STP	STEPS
STR	STRUCTURE
SWK	SIDEWALK
TEP	TELEPHONE PEDESTAL
TB	TOE OF OLD RR BED
TBK	TOP OF BANK
TBL	TOE OF BALLAST
TBP	TOP OF BORROW PIT
TBR	TOE OF BERM
TBS	TOP OF BALLAST
TC	TOP CONCRETE
TCB	TOP CONCRETE BANK
TCR	TOE CURB
TCS	TOP OF CONCRETE PAVEMENT (SLOPE)
TCW	TOP OF CONCRETE WALL
TEC	TOP ON EDGE OF CONCRETE WALL
TED	TOP EDGE OF DITCH
THR	THRESHOLD
TIP	3 INCH POST
TNK	TANK
TOB	TOE OF BORROW PIT
TOC	TOE OF CONCRETE WALL
TOD	TOE OF DITCH
TOE	TOE ON NATURAL GROUND
TOL	TOP OF LEVEE
TOP	TOP ON NATURAL GROUND
TOR	TOE ROCK
TOW	TOP OF WALL
TPC	TOP CURB
TEL	TELEPHONE LINE
TP	TOP OF OLD RR BED
TPB	TOP OF BERM

Code	Definition
TPL	TELEPHONE POLE
TPR	TOP ROCK
TPT	TOP SETTLEMENT PLATE
TPW	TOP OF CONCRETE WING WALL
TR	TREE
TRA	TOE OF GUARD RAIL
TRK	RR TRACK
TRL	TREE LINE
TRN	TRANSFORMER
TRW	TOE OF CONCRETE RETAINING WALL
TSP	TOP OF THE SHEET PILING
TWB	TOP WOOD BANK
TWR	TOWER
TWW	TOE OF CONCRETE WING WALL
UBX	UTILITY BOX
UGT	UNDERGROUND TELEPHONE LINE
UTL	UTILITIES
VAL	VALVE
WF	WATER FAUCET
WLN	WATER LINE
WBT	WOOD BANK TOE
WBK	WOOD BULKHEAD
WDP	WOOD PILING
WE	WATER EDGE
WES	WATER EDGE SURFACE
WFL	WOOD FENCE LINE
WL	WOODLINE
WLK	WALKWAY
WLS	WILLOW TREES
WM	WATER MAIN - METER
WMA	WATER MAIN HOLE
WR	WEIR
WRW	WOODEN RETAINING WALL
WS	WATER SURFACE
WSB	WISTERIA BUSH
WV	WATER VALVE
WW	WING WALL
XBR	BRIDGE CROSS BRACE

Table 14: Standard feature codes

15   Revision History

15.1   EM06

- Initial specification.

15.2   EM09

- Added #H00 record to declare file version.

- Generalized #H07 record to represent either State Plane or UTM coordinate reference system zones.

- Added #H16 and #H17 to represent horizontal epoch and horizontal accuracy.

- Expanded Vertical Accuracy (#H03) domain to include the '+-' notation to specify absolute accuracy in units of the survey (#H06).

- Added area records (#A01,#A02,#A03) to represent boundary surveys.

- Added description records to cross-sections (#X10-#X99), profiles (#P10-#P99), and equipment (#E10-#E99).

- Added optional name column to baseline records (#B01-#B999).

- Added disambiguation or spelling corrections for the following survey codes: BM, CFP, CP, EAR, EOR, MB, PIM, RCP, RP, WSB.

- Added new survey codes: LDR - LIDAR, WR - WEIR, SG - SECTOR GATE, GAG - GROUND AT GATE, STR - STRUCTURE, OCV - OVERHEAD CONVEYOR.

- Added USFEET and METERS as preferred units of measure (#H06) values. Expanded units of measure to include international feet as IFEET.

15.3   EM09 Revision 1

- Clarified that names on cross-section, profile, miscellaneous shot point, and area declaration records are optional.

15.4   EM09 Revision 2

- Removed quotes, commas, and abbreviations from the definitions for the following codes: AC, PIM, PIC,PIP,PIS,FIP,TIP,EOR,MET,RCP,HT,PT,PWC.

- Clarified that code lookups should be case-insensitive.

- Specified that codes in CODES.DAT files should not overwrite standard codes.

- Clarified that the humidity record (#W03) means relative humidity.

- Added detail to the cloud condition record (#W04).

15.5   EM09 Revision 3

- Clarified the issue of polygon closure for area records (#A01,#A02,#A03).

15.6   EM09 Revision 4

- Added new survey codes: BEG, END, CAL, CK.

15.7 EM09 Revision 5

- Added VERTICAL UPDATE to benchmark condition domain.

- Added NA2011 to horizontal epoch domain.

References

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[2] Mark Huber. Minimum Survey Standards for Performing Hydrographic, Topographic, and Geodetic Surveys. Technical Report CEMVN-ED-SS-06-01, U.S. Army Corps of Engineers, December 2006. `http://www.mvn.usace.army.mil/ed/edss/USACE_MVN_Min_Survey_Standards.PDF`.

[3] Engineering and Design - Geodetic and Control Surveying. Technical Report EM 1110-1-1004, U.S. Army Corps of Engineers, June 2002. `http://www.usace.army.mil/publications/eng-manuals/em1110-1-1004/`.

[4] National Geodetic Survey Data Sheets Web Site. http://geodesy.noaa.gov/cgi-bin/datasheet.prl.

[5] Frequently Asked Questions Survey Section, Design Branch, U.S. Army Corps of Engineers New Orleans District. `http://www.mvn.usace.army.mil/ed/edss/faq.asp\#EPOCH1`.

[6] Engineering and Design - Hydrographic Surveying, January 2000. `http://www.usace.army.mil/publications/eng-manuals/em1110-2-1003/toc.htm`.